Shaping of Pulses in Optical Grating-Based Laser Systems for Optimal Control of Electrons in Laser Plasma Wake-Field Accelerator

Csaba Tóth, Jerome Faure, Cameron G. R. Geddes, Jeroen van Tilborg, and W. P. Leemans
L'OASIS Group, Accelerator and Fusion Research Division,
Lawrence Berkeley National Laboratory, BLDG 71R0259,
1 Cyclotron Rd., Berkeley, CA 94720, USA, e-mail: ctoth@lbl.gov

Abstract
In a typical chirped pulse amplification (CPA) laser system, the final pulse-forming device is the grating pulse compressor itself. By scanning the grating separation, in addition to the primary changes of the linear chirp all the higher order terms are modified, too. By setting the compressor angle slightly different from the optimum, a typical scan around the shortest pulse will produce significant changes to the pulse shape. For example, when compressing stretched pulses with a positive bias third order phase component, the pulse shape in the course of a compressor separation scan initially will be skewed toward the head of the pulse (s<1), then flips to become a skewed pulse at the tail (s>1), and again flips back to the original asymmetric one (s<1). Examples of strong electron yield dependence in laser plasma wake-field electron acceleration experiments in the L'OASIS Lab of LBNL [W.P. Leemans et al., Phys. Rev. Lett. 89, 174802 (2002).] show the importance of the skewness parameter, s, defined here as the ratio of the 'head-width-half-max' (HWHM) and the 'tail-width-half-max' (TWHM), respectively. Further methods of higher-order phase-control will be reviewed, including the DAZZLER, a commercial acousto-optic phase and amplitude modulation device used in electron acceleration experiments.

* This work was supported by DOE Contract No. DE-AC-03-76SF0098. C.G.R.G. acknowledges the Hertz Foundation.